FOREST PEST MANAGEMENT

BIOLOGICAL EVALUATION
R2-96-01

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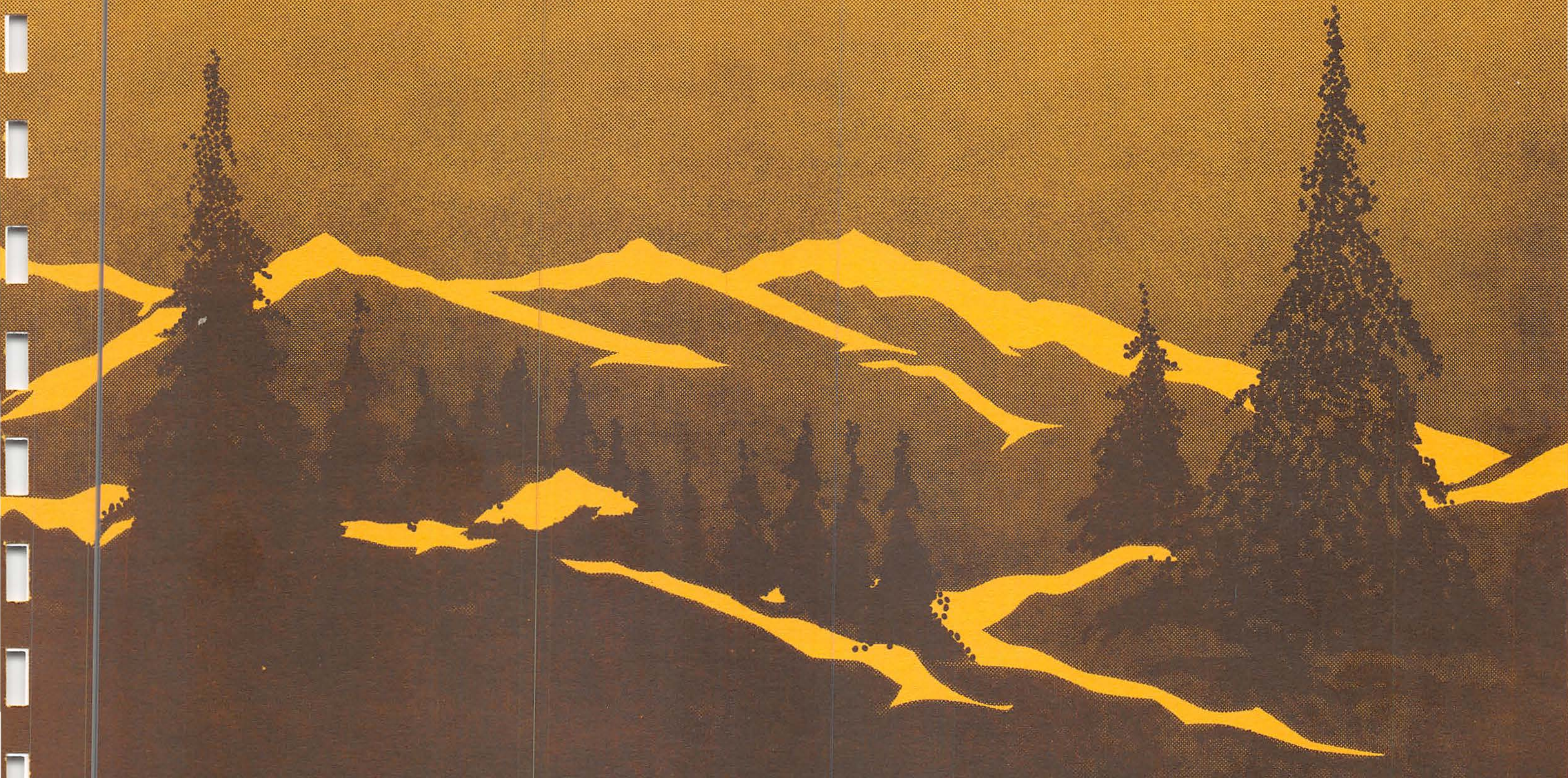
SEPTEMBER 1996



United States Department of Agriculture

Forest Service

Forest Pest Management
Denver, Colorado

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SEPTEMBER 1996

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ABSTRACT

Emergence patterns and population levels of Douglas-fir beetles (DFB), *Dendroctonus pseudotsugae* Hopkins, in the seventh year of infestation following the Clover Mist Fire were evaluated on the Clarks Fork Ranger District of the Shoshone National Forest. Adult emergence in 1995 returned to a single peak beginning in mid-June, about a week later than normal likely due to cold, wet spring weather. Adults of both the '93-'94 and '94-'95 generations emerged, demonstrating for the second year in a row that DFB can extend its life cycle up to two years. Almost half the total emergence of the '93-'94 generation was delayed until 1995, with an average of 4.0 DFB adults per sq. ft. of bark surface emerging in 1995. A majority of adults of the '94-'95 generation emerged in 1995; an average of 21 DFB adults emerged per sq. ft. of bark surface. A strong positive relationship was found between the percent of DFB brood overwintering as adults and the density of adults emerging in the subsequent spring.

From bark samples collected in late October 1995, overwintering brood densities for the '95-'96 generation were estimated to average 16.4 DFB per 36 sq. in. bark sample (or 65.5 per sq. ft. of bark surface). This was a decline of only 4% compared to fall 1994 samples. Seventy-two percent of the overwintering brood were adults, an increase of 5% over the preceding generation. An average of 3.7 DFB survived until fall per attacking parent. Natural enemy populations were at moderate levels at all three sample sites. The DFB population can be expected to remain stable or increase up to three-fold in 1996 based upon analyses of population levels of the '95-'96 generation, assuming normal winter weather conditions. Management alternatives to reduce the impact of the DFB epidemic are discussed.

INTRODUCTION

An outbreak of Douglas-fir beetle (DFB), *Dendroctonus pseudotsugae* Hopkins (Coleoptera: Scolytidae), began on the Clarks Fork Ranger District of the Shoshone National Forest in northwestern Wyoming following the Clover Mist Fire of 1988. Progression of the outbreak has been documented in yearly biological evaluations (Pasek 1990, 1991; Pasek and Schaupp 1992, 1995; Schaupp 1993; Schaupp and Pasek 1995). This evaluation is the seventh in a series.

The Clover Mist Fire, which originated in Yellowstone Park, burned onto the Clarks Fork Ranger District, generally south of U.S. Highway 212 and Wyoming Route 296 (Forest Route 100). Large numbers of DFB were detected in large-diameter, blackened Douglas-fir trees in 1989 (Pasek 1990). In 1990, DFB attacked scorched trees as well as green, apparently healthy Douglas-fir trees adjacent to burned areas and in pockets up to several miles distant from the fire boundary. DFB has continued to spread through most stands of large-diameter Douglas-fir on the Clarks Fork Ranger District. Estimates of tree mortality ranged from about 4000 to 5600 trees per year (unpublished aerial survey data). Stands adjacent to the burned area are becoming depleted of suitable large-diameter Douglas-fir hosts.

Brood production has fluctuated between stable and increasing levels from 1989 to 1995. Poor overwintering survival in some years appeared to be the predominant mortality factor keeping the DFB population from increasing as rapidly as predicted from fall brood samples. The proportion of brood overwintering as callow adults has fluctuated between 21% and 92% (Pasek and Schaupp 1995). High percentages of brood overwintering as immatures likely contributed to higher levels of overwintering mortality in certain years. DFB is also able to extend its life cycle to two years by delaying adult emergence when conditions are not ideal for development (Pasek and Schaupp 1995).

The evaluation documented herein was conducted to monitor the DFB population in order to develop predictions of the course of the infestation for 1996 and to continue to collect useful biological observations. Adult emergence from trees infested by the '93-'94 and '94-'95 generations was monitored and overwintering population levels for the '95-'96 generation were examined.

METHODS

In early May 1995, wire-mesh screen cages (one ft. by two ft.) were attached to the north sides of 10 standing, Douglas-fir that were infested by the '94-'95 DFB generation. Cages were located at four sites along Wyoming Route 296: Deadman Creek (two cages), east of Camp Creek (three cages), Sugarloaf (three cages), and K-Z Ranch (two cages). Adult DFB that emerged under these cages were collected approximately weekly beginning May 26 through October 11, 1995. Collected DFB were stored in alcohol and transported to the Rapid City Service Center office, where they were counted and their sex was determined.

Additionally, three cages at Deadman Creek that had been attached in early May 1994 (i.e., on trees infested by the '93-'94 DFB generation) were checked in the same manner. The objective was to collect information about emergence following prolonged development of up to two years.

On 24-25 October 1995, bark samples (six in. by six in.) were removed at a height of 5-7 ft. from the north and south side of each of 32 Douglas-fir trees currently infested by DFB. Sample sites were located at Sugarloaf, Badger Spring, and Beem Gulch. Diameter at breast height (DBH) was recorded for each sample tree. Live DFB and DFB natural enemies dislodged from the bark sample during removal were identified, counted, and discarded. Number of gallery starts also was counted. Bark samples were stored in plastic bags and transported to the Rapid City Service Center office, where they were examined. Total inches of egg gallery was measured for each bark sample. Phloem was shaved with a knife to locate all remaining live insects in each sample. Numbers of live DFB

brood were tallied by life stage and DFB natural enemies were counted. Means and standard deviations by sample site were calculated for all variables measured.

On 26 October 1995, bark samples were removed from several caged trees using the same methods. Samples were taken from the north side (beneath cages) of three trees caged in May 1994 at Deadman Creek and the south side (opposite cages) of one tree at each of three locations caged in May 1995 (for which cages were left in place): Sugarloaf, east of Camp Creek, and Deadman Creek. For the other seven trees caged in 1995, two bark samples were taken, one from under the caged area and the other from the opposite side of the tree. Bark samples were handled and examined as described above.

RESULTS AND DISCUSSION

DFB emergence in 1995 began in late May and continued into early October, with a single peak in mid-June to mid-July (fig. 1). The emergence was similar to previous years, with the exception of 1994 when two peaks occurred (fig. 2). The June emergence peak in 1995 was about one week later than in most years previous, likely due to a cold, wet spring. The return to a single peak beginning in June corresponds to a return to an overwintering brood comprised largely of callow adults (Pasek and Schaupp 1995).

Adults emerged from all three trees caged in May 1994 ('93-'94 generation), confirming for a second year in a row that DFB can survive two winters and emerge following an extended life cycle of approximately two years duration (Pasek and Schaupp 1995). Most of these DFB emerged in June, with a couple emerging in July. No live DFB were found remaining in bark samples from beneath cages of the three trees by fall of 1995. Emergence of DFB from the '93-'94 generation that survived to 1995 ranged from 2-19 per cage or 1-9.5 per sq. ft. of bark surface, and averaged 4.0 per sq. ft. of bark surface (standard deviation = 4.8, n = 3 cages). This level of emergence is slightly higher than that reported for delayed emergence in 1994, and is about half the amount predicted to be overwintering a second year based upon fall '94 bark samples on caged trees (Pasek and Schaupp 1995). A total of 24 DFB emerged from the three cages, 21 of which were female. For the '93-'94 generation, combined adult emergence for '94 and '95 approximated 8.8 DFB per sq. ft. of bark surface.

For trees attacked in 1994 and caged in 1995 ('94-'95 generation), a total of 420 adult DFB were collected from emergence cages. This averages 21 adult DFB per sq. ft. of bark surface using total DFB collected per cage over the entire trapping period (standard deviation = 30.7, n = 10 cages). The range of total DFB collected per cage was 8-90 DFB adults or 4-45 DFB per sq. ft. Mean emergence ranged from 10.5 DFB per sq. ft. at the K-Z Ranch site to 28.8 DFB per sq. ft. at Deadman Creek, with the sites at Sugarloaf and near Camp Creek intermediate at 19.5 and 24.3 DFB per sq. ft., respectively. Slightly more females (52%) emerged than males, of those DFB for which sex could be determined.

Live DFB adults were detected in fall 1995 bark samples for only one tree caged in 1995 to monitor the '94-'95 DFB generation. A total of seven DFB adults were found in two bark samples taken from a caged tree at the Sugarloaf site, which is equivalent to 14 DFB per sq. ft. of bark surface (mean = 1.4 + 4.4 sd, n = 10). Because only one-third of the '94-'95 DFB generation overwintered as immatures (Pasek and Schaupp 1995), relatively few beetles are expected to delay emergence until 1996.

Population trend for a generation can be estimated by dividing the density of emerging beetles by twice the density of gallery starts (attacks), assuming a pair of beetles initiates each attack. When the ratio of emergence to attack exceeds one, the population trend is increasing; when the ratio is less than one, the population trend is decreasing. For the '94-'95 DFB generation, the population trend was 1.3, indicating a modest increase in population. This is less than the two-fold to three-fold increase predicted by Pasek and Schaupp (1995) and suggests that overwintering mortality was relatively high.

Fig. 1. Douglas-Fir Beetle Emergence by Week of Collection from 13 Trees, each with a 1 X 2 Foot Cage, Cathedral Cliffs Area, Wyoming, 1995

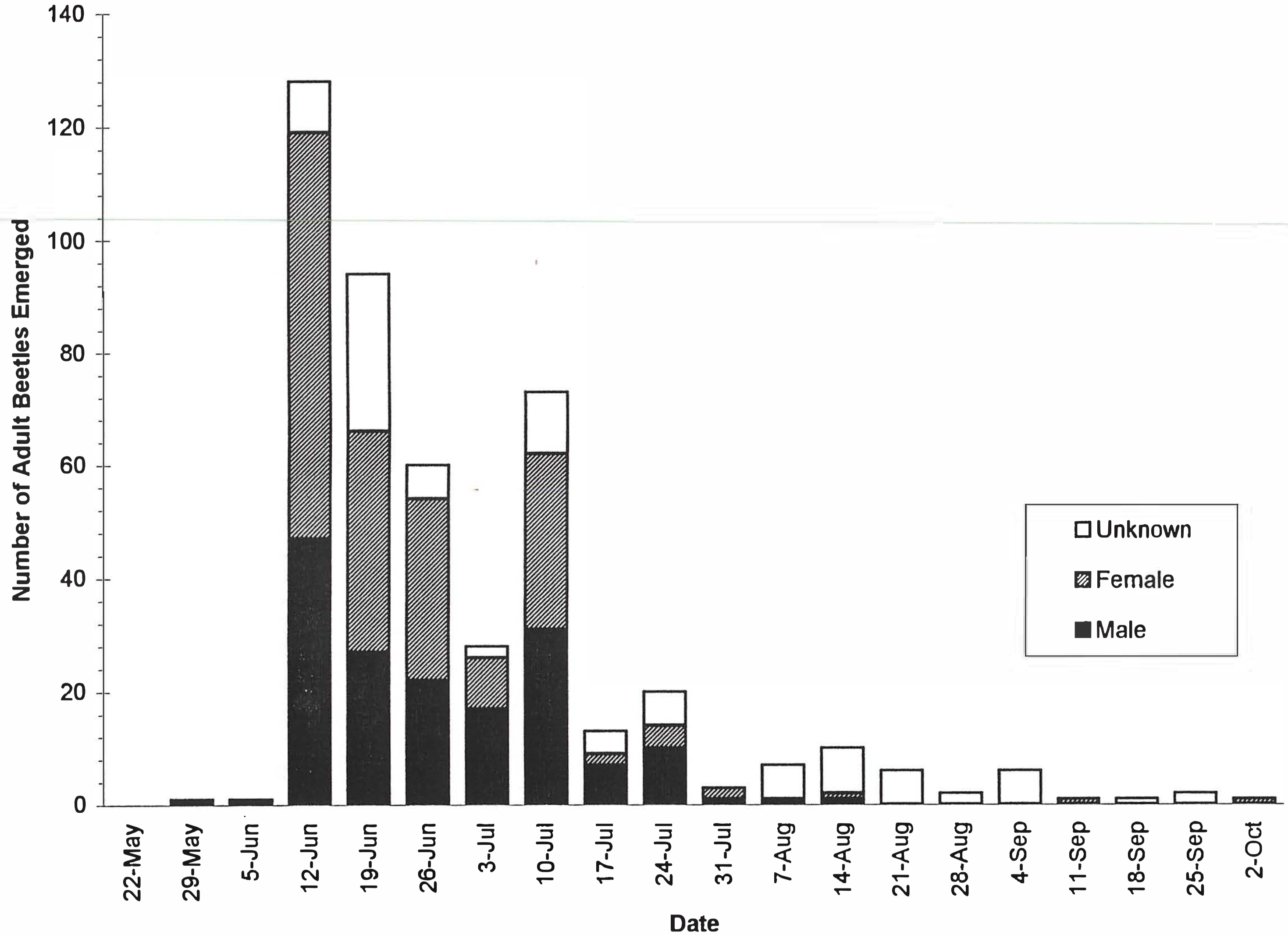
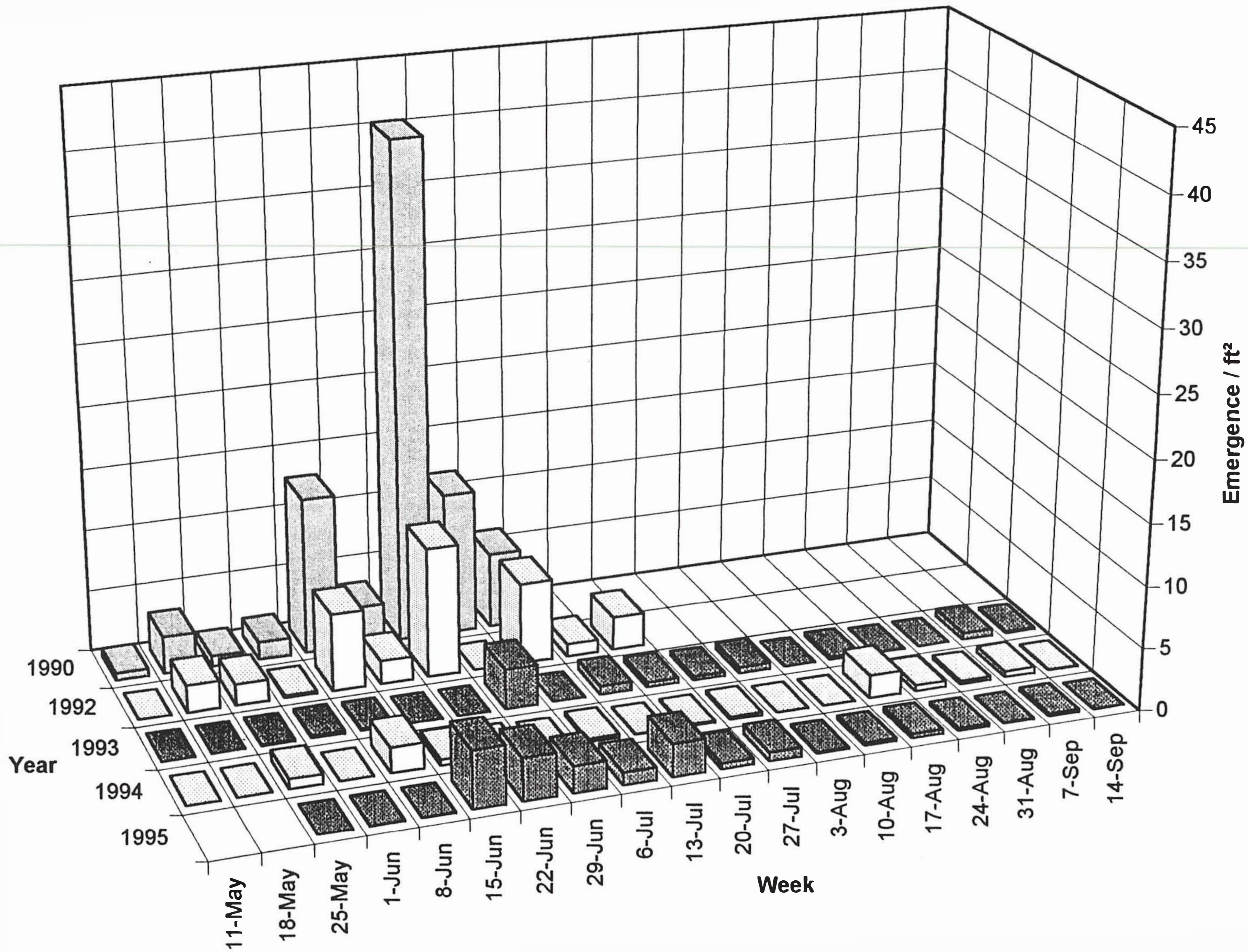


Fig. 2. Douglas-fir beetle emergence by week for five years, Clarks Fork Ranger District, Shoshone NF, Wyoming



Mean emergence of the '94-'95 generation represented about one-third of the brood density found in fall '94 bark samples (Pasek and Schaupp 1995), and was about three to four times greater than emergence levels of the preceding two years when overwintering broods were predominately composed of immatures (Schaupp and Pasek 1995; Schaupp 1993). The survival level of the '94-'95 generation resulted from a fall brood comprised of 67% adults (Pasek and Schaupp 1995). Based upon five generations of observations, there appears to be a strong positive correlation between percent of DFB brood overwintering as adults and the density of adults emerging in the subsequent spring (delayed emergence was not included in the analysis) ($r2 = 0.9723$, $p = 0.002$). The regression line representing this relationship may be described by the equation:

$$y = 2.4897e^{0.036x},$$

where x is the percent of brood overwintering as adults and y is number of adults emerging per sq. ft. of bark surface (fig. 3). Such a relationship, if it holds for additional observations, would be useful in refining predictions of population trend based upon fall brood samples.

Overwintering brood density of the '95-'96 DFB generation averaged 16.4 DFB per 36 sq. in. sample or 65.6 per sq. ft. of bark surface (Table 1). Brood production at the Beem Gulch site was almost three times that of the Sugarloaf site and double that of the Badger Spring site. Beetles likely were running out of the best host trees at the Sugarloaf site after several years of infestation, which likely affected survival of DFB brood. The Beem Gulch site was of more recent infestation. None of the bark samples contained pitched out areas. Mean overwintering brood density of fall 1995 samples declined a slight 4% compared to fall 1994 samples (fig. 4).

Seventy-two percent of all overwintering broods were new or callow adults, an increase of 5% from the fall 1994 brood samples (fig. 5). About 18% of the sample brood were larvae and 10% were pupae. Percentage of adults was highest at the Sugarloaf site and lowest at the Beem Gulch site.

Mean number of gallery starts per sample remained consistent with those of prior years, averaging 2.2 per sq. in. of bark surface overall and ranging from a mean of 2.1 at Sugarloaf to 2.6 at Beem Gulch (Table 1). This level of gallery attack is generally indicative of increasing population levels (Lessard and Schmid 1990) and maximum brood production (McMullen and Atkins 1961). Assuming that one female and one male initiate each gallery, an average of 17.6 adults attacked each sq. ft. area of infested bark surface.

Mean total egg gallery length per bark sample ranged from 22.8 at Sugarloaf to 28.0 at Beem Gulch (or 91.2 to 112.0 in. per sq. ft.) (Table 1). These gallery densities exceed the range of 30 - 60 in. per sq. ft. considered by McMullen and Atkins (1961) to represent maximum brood production levels. The high gallery densities apparently did not adversely affect brood production and survival (particularly due to crowding) since the Beem Gulch site, which had the highest mean levels of gallery starts and gallery density, had the highest mean level of brood production of the three sites sampled.

Moderate levels of DFB natural enemies (predatory beetles and parasitic wasps and flies) were detected in bark samples at all three sites (Table 1). Density of parasitic wasps at Beem Gulch was about half that of the Sugarloaf and Badger Spring sites, but the differences were not great enough to account for much of the variation in live fall brood densities between the three sample sites.

An index of population change representing the number of DFB brood produced per attacking adult can be calculated by dividing the mean density of total brood by twice the mean density of gallery starts. For the '95-'96 generation, a population change index calculated from the mean for all three sites forecasts a potential increase of up to 3.7 times as many DFB emerging at the end of the generation (assuming no further mortality from fall to spring) as there were parent beetles. Population change indices for Sugarloaf, Badger Springs, and Beem Gulch were 2.3, 3.5, and 5.1, respectively, based upon fall brood densities. Actual population levels of emerging adults in spring and summer of 1996 will likely be less than predicted because of additional brood mortality, especially

Fig. 3. Relationship between percent of Douglas-fir beetle brood overwintering as adults and subsequent density of emerging beetles for five generations on the Clarks Fork Ranger District, Shoshone National Forest, Wyoming

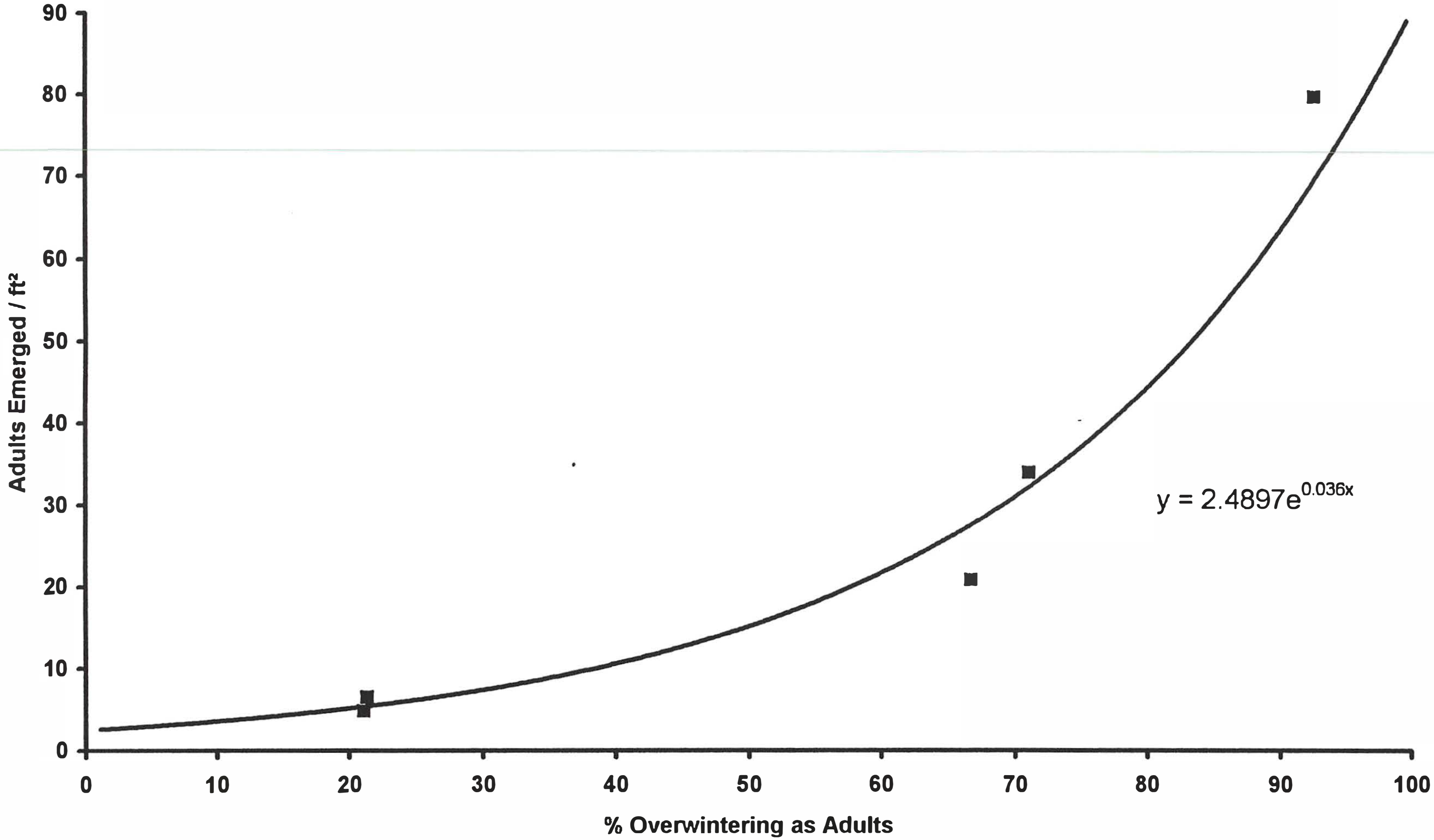


Table 1. Douglas-fir beetle overwintering brood production, gallery characteristics and natural enemy numbers per 36 square inches of bark surface of two samples per successfully attacked tree taken at 5-7 feet height in the Clarks Fork Ranger District, Shoshone National Forest, Wyoming, October 1995 (means ± standard deviation).

	Aspect	Sugarloaf		Badger Spring		Beem Gulch		All Sites	
# Trees		10		12		10		32	
DBH		16.9 ±	2.7	17.9 ±	3.4	17.4 ±	2.8	17.4 ±	3.0
Eggs	Both	0.0		0.0		0.0		0.0	
Larvae	North	0.8 ±	1.5	3.3 ±	5.5	5.2 ±	5.7	3.1 ±	4.9
	South	1.9 ±	2.2	2.1 ±	3.1	4.7 ±	3.7	2.8 ±	3.2
	Both	1.4 ±	2.0	2.7 ±	4.4	5.0 ±	4.7	3.0 ±	4.1
Pupae	North	0.4 ±	0.7	0.8 ±	2.1	4.4 ±	4.7	1.8 ±	3.3
	South	0.6 ±	1.1	0.3 ±	1.2	3.7 ±	3.5	1.5 ±	2.6
	Both	0.5 ±	0.9	0.5 ±	1.6	4.1 ±	4.0	1.6 ±	3.0
Adults	North	8.2 ±	4.0	9.8 ±	6.8	13.2 ±	8.6	10.3 ±	6.9
	South	7.7 ±	7.1	10.8 ±	8.0	21.9 ±	11.5	13.3 ±	10.6
	Both	8.0 ±	5.6	10.3 ±	7.3	17.6 ±	10.8	11.8 ±	9.0
Total Brood	North	9.4 ±	5.4	13.8 ±	6.0	22.8 ±	10.9	15.2 ±	9.3
	South	10.2 ±	8.1	13.2 ±	6.8	30.3 ±	14.0	17.6 ±	13.0
	Both	9.8 ±	6.7	13.5 ±	6.3	26.6 ±	12.8	16.4 ±	11.3
Gallery Starts	North	2.1 ±	0.7	2.0 ±	1.0	2.2 ±	0.7	2.1 ±	0.8
	South	2.1 ±	1.1	1.8 ±	0.8	2.9 ±	1.0	2.3 ±	1.0
	Both	2.1 ±	0.9	1.9 ±	0.8	2.6 ±	0.9	2.2 ±	0.9
Egg Gallery Length	North	20.9 ±	6.3	23.3 ±	11.6	25.4 ±	6.6	23.2 ±	8.7
	South	24.7 ±	7.3	24.8 ±	10.9	30.6 ±	7.9	26.6 ±	9.1
	Both	22.8 ±	6.9	24.0 ±	11.0	28.0 ±	7.6	24.9 ±	9.0
DFB Enemies: Beetles	North	0.4 ±	0.7	0.2 ±	0.4	0.2 ±	0.4	0.3 ±	0.5
	South	0.2 ±	0.4	0.2 ±	0.4	0.2 ±	0.4	0.2 ±	0.4
	Both	0.3 ±	0.6	0.2 ±	0.4	0.2 ±	0.4	0.2 ±	0.5
DFB Enemies: Wasps	North	4.5 ±	5.4	3.6 ±	5.4	1.8 ±	2.7	3.3 ±	4.7
	South	3.4 ±	5.5	3.3 ±	3.5	1.6 ±	2.2	2.8 ±	3.9
	Both	4.0 ±	5.4	3.4 ±	4.5	1.7 ±	2.4	3.0 ±	4.3
DFB Enemies: Flies	North	1.0 ±	1.1	0.9 ±	1.5	1.5 ±	1.5	1.1 ±	1.4
	South	1.3 ±	1.3	1.3 ±	2.1	1.1 ±	1.5	1.2 ±	1.6
	Both	1.2 ±	1.1	1.1 ±	1.8	1.3 ±	1.5	1.2 ±	1.5

Fig. 4. Douglas-fir beetle overwintering brood by year, Clarks Fork Ranger District, Shoshone NF, Wyoming

(lines atop bars represent standard error of mean total brood)

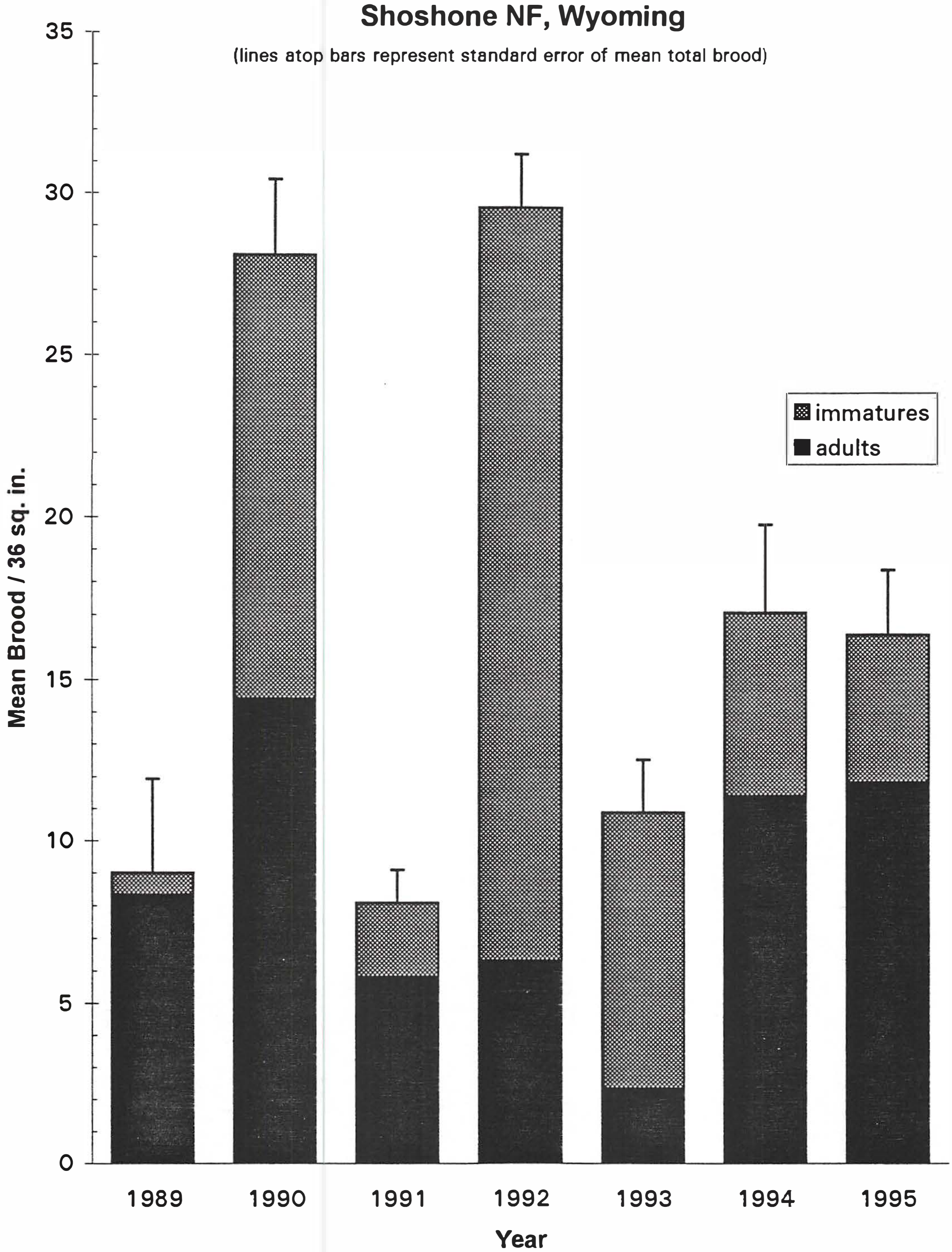
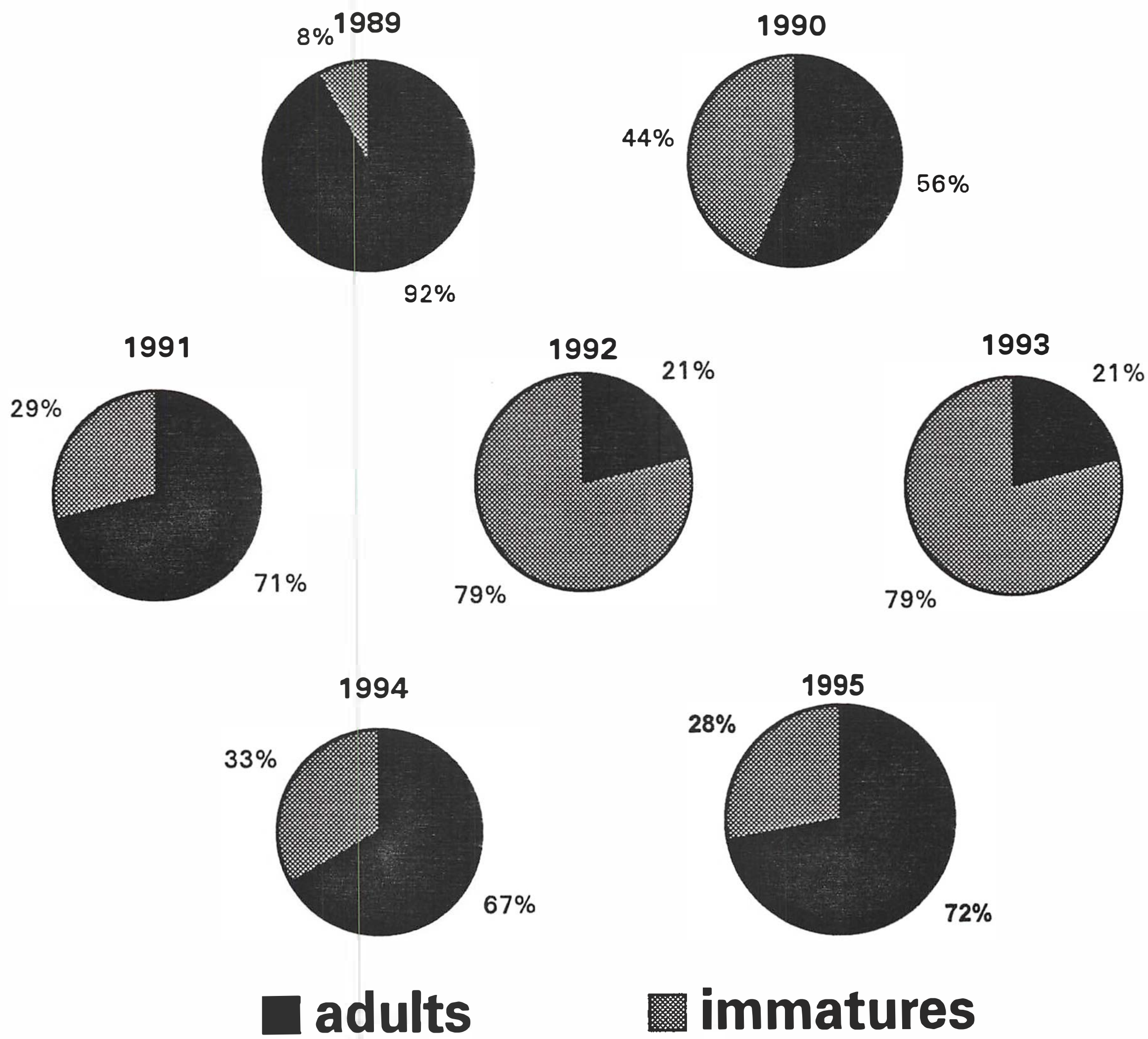


Fig. 5. Percentages of overwintering adult and immature Douglas-fir beetles from late fall samples of bark taken at 5-7 foot height from successfully attacked trees in the Clarks Fork Ranger District, Shoshone National Forest, Wyoming, for 7 years following the Clover Mist Fire of 1988.



during winter months. Both abiotic and biotic agents act to further reduce population size, but the magnitude of these influences is largely unpredictable. Using the regression relation between percent of population overwintering as adults and subsequent emergence, a prediction can be made of 33 DFB adults emerging per sq. ft. of bark surface during 1996. Substituting this number for total brood density in the calculation of population change index results in a prediction of a 1.9-fold increase for the '95-'96 generation. Based upon these analyses, a stable or increasing (up to about three-fold) population is likely in 1996. This is likely to vary by site as areas where suitable host trees are depleted will see declines in levels of further tree mortality. A population increase should be reflected in greater numbers of trees being attacked in 1996 across the affected area. This evaluation indicates that the DFB epidemic has not yet collapsed.

ALTERNATIVES

Several methods are available to reduce populations of DFB and the resultant tree mortality. These pest management strategies may focus on the reduction of infested material, reduction of susceptible host material, or prevention of new attacks. The decision to use a particular method should be predicated on considerations of stand conditions, location, management objectives, economics, social values, and other factors.

Alternative 1:

Sanitation Harvesting - Fell infested trees and remove them from the site for mill processing prior to adult DFB emergence. Stands with the highest percentages of large-diameter Douglas-fir should be given priority.

Where to use - Sites with the following conditions are appropriate:
accessible to logging operations such as near existing roads or where roads can be readily constructed; less than 40% slope; where human disturbance will not adversely affect special resource values; and in proximity to high value areas that need to be protected.

Advantages - Beetle broods can effectively be eliminated in small, isolated loci by removing all infested trees prior to beetle emergence. Beetle populations in larger groups can be significantly reduced. Sanitation harvesting provides a degree of protection to surrounding, uninfested trees by removing a nearby source of attacking beetles, recovers timber volume that otherwise would be lost, reduces fuel load, reduces subsequent hazard from falling trees and inaccessibility to large animals, reduces visual impact of dead and dying trees, and will encourage regeneration and greater diversity of size and age classes across the forest.

Disadvantages - Short implementation time is required; trees must be removed prior to adult emergence in the spring following attack. Adverse disturbance of the site and soil is possible. Sanitation harvesting may remove tree cover in spots or at a density considered adverse aesthetically.

Alternative 2:

Tree Baits - Commercially available DFB tree baits containing attractant semiochemicals (aggregation pheromone) can be used to concentrate beetles in trees that can be subsequently harvested. Baits are deployed just prior to beetle flight (May) and baited trees must be felled and removed or destroyed prior to the next adult emergence period (i.e., within one year).

Where to use - Ideal sites for placement of baits would be Douglas-fir trees in and around salvage operations. Baited areas must be suitable for harvest (Alternative 1) or mechanical control (Alternative 3). Baiting is likely to be most effective in areas where beetle populations are small; e.g., it is useful as a mop-up operation following removal of infested trees. Baiting is not suitable for large population centers; the native beetle population quickly overwhelms the baits in this situation.

Advantages - Baiting may provide some degree of redirection of beetle attacks to trees where salvage can be implemented. Beetles emerging from infested trees that were missed during salvage harvesting in one year may be concentrated in logs or trees for removal the following year.

Disadvantages - Application is generally limited to sites accessible to harvest and where beetle populations are low and relatively isolated from larger population centers.

Alternative 3:

Mechanical Control - Fell and buck infested Douglas-fir trees and treat them by burning, peeling the bark, or chipping the logs.

Where to use - Use in unroaded areas or on steep slopes that are accessible on foot (or horseback) to logging but where road building or skidding is undesirable. Sites where no logging company is interested in bidding on the timber or volume is too small to put up a sale also are appropriate.

Advantages - Much of the beetle brood can be eliminated from small pockets even in the absence of a timber market. Mechanical control provides a degree of protection to surrounding, uninfested trees by removing a nearby source of attacking beetles. It also reduces subsequent hazard from falling trees and inaccessibility to large animals, reduces visual impact of dead and dying trees, and will encourage regeneration and greater diversity of size and age classes across the forest. Potential for site and soil disturbance is less than for Alternative 1.

Disadvantages - Mechanical control is labor intensive, does not recover value and volume from trees, leaves a high fuel load on the site, removes tree cover, and requires a short implementation time; trees must be treated prior to adult emergence in the spring following attack. It is not effective where large populations are present in adjacent areas.

Alternative 4:

Trap Trees - Green trees can be felled and left on the site to attract beetles. Felled logs are sprayed with carbaryl in April or May, just prior to the beetle attack period, so that beetles will be killed as they enter the logs. Tree baits can be used on felled logs to increase their attractiveness to beetle attack.

Where to use - Use in small infestation pockets where salvaging, mechanical control, or reentry is impractical. Also use in unroaded areas or on steep slopes that are accessible on foot (or horseback) to logging but where road building or skidding is undesirable. Sites where no logging company is interested in bidding on the timber or volume is too small to put up a sale also are appropriate. Trap trees may be used as a tool to mop-up a population following salvaging.

Advantages - Use of trap trees concentrates beetle attack away from trees where protection is desired, kills beetles, does not require sale preparation and administration, can be used on sites

with steep slopes or where roads do not exist and are not desirable, and is not as labor intensive as mechanical control.

Disadvantages - Use of trap trees does not recover value and volume from trees, leaves a high fuel load on the site, and removes tree cover.

Alternative 5:

Silvicultural Treatment - To reduce susceptibility in green stands, basal area should be reduced below 80% of normal stocking (Furniss et al. 1981). Mature and old stands of Douglas-fir can be harvested. Younger stands should be thinned periodically to improve vigor and reduce moisture stress.

Where to use - This is a preventative treatment that should be considered as an ongoing part of the regular timber program. Due to limited staffing and funding, this alternative may not be feasible during an epidemic where resources are better spent on other options.

Advantages - Silvicultural treatment reduces susceptibility of stands to beetle attack, which may limit tree mortality and infestation size in the event of a future increase in beetle population.

Disadvantages - This alternative is not suitable for sites where harvesting activity is not desirable, such as in wilderness, on steep slopes, or where visual quality would be adversely impacted.

Alternative 6:

Protection of High Value Trees - Prior to beetle flight in early spring (April or May), the boles of valuable trees can be sprayed with carbaryl to prevent DFB attack.

Where to use - This method would be appropriate for use in and around campgrounds and private homes. Trees must be of high value. Insecticide application is not effective for trees that have already been infested.

Advantages - Insecticide application provides a degree of protection not currently available through other pest management strategies. Carbaryl has a low mammalian toxicity and low residual activity, which means it remains in the environment for a short period of time.

Disadvantages - Efficacy for protection of Douglas-fir needs to be demonstrated by a test prior to operational usage. Material is toxic to other insects as well as to DFB. Many citizens have concerns about environmental contamination and safety. Insecticide application does not effectively reduce the existing beetle population, is expensive if very many trees are treated, and size of treatment areas need to be small due to cost and labor considerations.

Alternative 7:

Repellents - A granular controlled-release formulation of the DFB antiaggregative pheromone, 3-methyl-2-cyclohexen-1-one (MCH), can be broadcast or aerially applied to stands where protection is desired. This alternative currently requires an experimental use permit, because registration of the material with Environmental Protection Agency (EPA) is not yet completed.

Where to use - The method is most suited for high value and inaccessible stands that are not currently infested but are threatened by nearby beetle populations.

Advantages - MCH is nontoxic; it is a natural chemical that is produced by DFB. Use of MCH is a promising method of preventing new attacks.

Disadvantages - MCH does not directly reduce the existing beetle population. Granular application distributes plastic pellets into the environment. Availability of the material may be a problem. MCH is not yet registered and has not been tested to determine the efficacy for protection of standing, green trees.

Alternative 8:

Do Nothing - Accept tree mortality caused by DFB as a natural phenomenon.

Where to use - Use where other control alternatives cannot be effected or are not desired. This may be the only viable alternative for infested stands that are inaccessible, areas designated as Wilderness, and sites where the visual and erosive impacts of harvesting are a major concern.

Advantages - No unnatural site disturbance or introduction of foreign materials into the environment will occur. Change in vegetation follows a natural event.

Disadvantages - The no action alternative allows the beetle population to continue to increase and threaten additional sites. Tree volume and value is lost, visual quality is adversely affected by dying and dead trees, fuel load increases, tree hazard increases, inaccessibility to large animals increases with time as trees fall over, and tree regeneration is inhibited due to shading by remaining dead trees and lack of seedbed preparation.

RECOMMENDATION

Sanitation (or salvage) harvesting (Alternative 1) may be appropriate for areas with relatively high levels of tree infestation or mortality. For other sites, emphasis should be placed on long-range management planning to increase the health of forest stands and reduce susceptibility to DFB attack (Alternative 5). This is particularly appropriate for stands in the suitable timber base where emphasis is placed on timber production and for areas where loss of tree cover is undesirable. Priority for silvicultural treatment should be given to older, dense stands of predominantly Douglas-fir composed of large diameter (> 16 inches DBH) trees. Forest Health Management staff are working on a stand risk/hazard rating system for DFB that can serve as an aid to prioritizing stand treatments and assessing effects of various management alternatives in the future.

Removal of currently-infested trees (Alternative 1) should be incorporated into any harvesting or thinning operations, to further reduce DFB populations in the immediate vicinity. This alternative is appropriate for stands being managed to improve long-term sustainability (Alternative 5) and for stands where tree losses are imminent and a reduction in DFB impact is currently desirable (e.g., salvage sales).

Alternative 4 may be appropriate where baits can be used to lure residual DFB populations to log decks for subsequent removal. Successive baiting and sanitation harvesting may be needed using this method.

DFB populations likely are still too high for Alternative 2 to be effective. The natural pheromone of the beetles may overwhelm artificial baits attached to standing, green trees such that infestation spreads beyond the intended area. This alternative is not recommended at present.

Alternatives 3 and 6 may be useful for treating or protecting high value sites, such as campgrounds or homesites.

Alternative 8 may be selected of necessity in much of the Clarks Fork Ranger District because of extensive areas of Wilderness affected by the Clover Mist Fire, concerns for the protection of certain wildlife species, the presence of inaccessible areas, the concern for visual and erosive impacts of harvesting options, and the constraints on time and personnel available to treat infested sites.

Land managers need to develop site-specific plans to manage stands relative to anticipated effects of DFB in relation to desired conditions and resource objectives stated in a Forest Plan. Alternatives should be weighed in relation to site-specific characteristics.

Forest Health Management personnel will continue to assist in reassessing DFB populations and DFB-caused tree mortality as needed during the course of the infestation.

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